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Distraction and Pedestrian Safety: How Talking on the Phone, Texting, and Listening to Music Impact Crossing the Street

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Abstract

As use of handheld multimedia devices has exploded globally, safety experts have begun to consider the impact of distraction while talking, text-messaging, or listening to music on traffic safety. This study was designed to test how talking on the phone, texting, and listening to music may influence pedestrian safety. 138 college students crossed an interactive, semi-immersive virtual pedestrian street. They were randomly assigned to one of four groups: crossing while talking on the phone, crossing while texting, crossing while listening to a personal music device, or crossing while undistracted. Participants distracted by music or texting were more likely to be hit by a vehicle in the virtual pedestrian environment than were undistracted participants. Participants in all three distracted groups were more likely to look away from the street environment (and look toward other places, such as their telephone or music device) than were undistracted participants. Findings were maintained after controlling for demographics, walking frequency, and media use frequency. Distraction from multimedia devices has a small but meaningful impact on college students' pedestrian safety. Future research should consider the cognitive demands of pedestrian safety, and how those processes may be impacted by distraction. Policymakers might consider ways to protect distracted pedestrians from harm and to reduce the number of individuals crossing streets while distracted.

Keywords

injury; safety; pedestrians; phone; text-messaging; texting; distraction; music; street-crossing

Use of handheld multimedia devices is growing exponentially worldwide (Giridharadas, 2010; Wilson & Kimball, 2010). Recent data from the United States indicate over 80% of the adult population owns cell phones (Cellular Telecommunications & Internet Association, 2010; Wilson & Kimball, 2010) and nearly 50% owns portable mp3 devices to listen to music (Pew Research Center, 2010). Global data are similar. As examples, industry experts estimate 77% of the world's population owns a mobile phone, 6.1 trillion text messages were sent worldwide in 2010 (equivalent to 200,000 text messages every second; MobiThinking, 2011), and 84% of young adults (ages 18–24) in Britain own mp3 players (British Music Rights, 2008).

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Although handheld multimedia devices offer substantial convenience, benefit, and entertainment to users, the injury prevention community has expressed concern about their potential to distract individuals from safe engagement in potentially hazardous environments. The automobile driving literature in particular has examined the issue and discovered that both telephone conversations (Collet, Guillot, & Petit, 2010a, 2010b; McEvoy et al., 2005) and texting (Drews, Yazdani, Godfrey, Cooper, & Strayer, 2009; Hosking, Young, & Regan, 2009) reduce drivers' attention to the road environment and substantially increase risk of motor vehicle crashes, injuries, and fatalities. Results concerning the effect of distraction by listening to music are more mixed, with most studies suggesting listening to music has minimal effect on driving safety (although manipulation of music controls such as volume is distracting; see Bellinger, Budde, Machida, Richardson, & Berg, 2009; Dibben & Williamson, 2007).

Recently, scientists have shown increased interest in extending work on the role of distraction among drivers to the influences on pedestrian safety (Bungum, Day, & Henry, 2005; Hatfield & Murphy, 2007; Nasar, Hecht, & Werner, 2008; Neider, McCarley, Crowell, Kaczmarski, & Kramer, 2010; Stavrinos, Byington, & Schwebel, 2009, 2011). Pedestrian injury represents a major public health issue, particularly among the population of interest for this study, college students. In 2009, almost 800 young Americans (ages 16–29) were killed as a result of pedestrian-related injuries, and roughly 16,000 required hospital visits (National Highway Traffic Safety Administration, 2009).

Recent findings from observational research suggest pedestrians who are distracted by phone conversations or other activities (e.g., eating, listening to music) take greater risks when crossing streets (Bungum et al., 2005; Hatfield & Murphy, 2007; Nasar et al., 2008). A within-subjects experiment with children crossing the street in a virtual pedestrian environment while talking on the phone yielded similar results (Stavrinos et al., 2009), as did two studies examining the effect of phone conversations on adult pedestrians crossing in simulated environments (Neider et al., 2010; Stavrinos et al., 2011) and a study of older adults (Neider et al., 2011). We are unaware of any controlled experiments examining the risk of distraction on adult or college student pedestrians while texting.

The present study was designed to consider the role of distraction by phone conversations, texting, and listening to music on college students' pedestrian safety. We examined pedestrian behavior within an interactive, semi-immersive virtual pedestrian environment previously validated to represent real-life pedestrian behavior (Schwebel, Gaines, & Severson, 2008). This permitted us to test potentially dangerous pedestrian behavior in an ethical manner. The study was conducted using a between-subjects design whereby participants were randomly assigned to talk on the phone, text, or listen to music while crossing the virtual street. A no-distraction control group was also included.

Methods

Participants

One hundred and thirty-eight participants were recruited from an introductory psychology course (ages 17–45, mean age = 20.91 years, *SD* = 4.50 years). The sample included 88 women (64%) and 50 men (36%), and was diverse in terms of racial/ethnic backgrounds (54% Caucasian, 26% African American, 11% Asian American, 4% Hispanic, and 6% other or mixed background). In rare cases of missing data (< 7% for any one variable and < 3% for most), pairwise deletion was used, such that individual analyses were conducted without participants when a data point was missing. One full case was dropped due to failure to comply with the protocol. The protocol was reviewed and approved by the university's ethics board. All participants provided informed consent and received course credit for participation.

Covariate Measures

Participants completed three written questionnaires. First, a brief demographic questionnaire yielded self-reported information, including age (in years) and gender. Second, participants completed a walking diary to document their recall of “typical” walking patterns on two days of the week (Monday and Thursday). In the diary, they recorded their typical public walking behavior beginning with the morning and continuing through bedtime. All walks outdoors (e.g., between classes, in parking lots, for exercise) were recorded, including the distance (in blocks) and duration (in minutes) of each walk. We created an aggregate of recalled walking frequency by averaging reports across the two days, standardizing the averages, and then averaging the two computations (standardized average blocks walked and standardized average minutes walked). The two scores (blocks and minutes) correlated strongly ($r = .59$, $p < .01$).

Third, participants completed a “media use questionnaire” to report their typical use of cell phones for talking and texting, and typical use of music listening devices. Of particular interest were six items that asked about average time spent talking on cell phones during weekdays and weekend days (in minutes), average number of text messages sent on weekdays and weekend days (number of texts), and average time spent listening to music on a personal listening device on weekdays and weekend days (in minutes). In each case, weekday and weekend figures were standardized and averaged to create aggregates of cell phone use (talking), texting frequency, and music listening frequency. Weekday and weekend usage were highly correlated for phone-talking, texting, and music-listening (*r*s = .66, .88, and .56, respectively, all *p*s < .01).

Pedestrian Behavior: Protocol and Measures

Protocol—Software, hardware, and experimental protocol details for the virtual pedestrian environment appear elsewhere (Schwebel et al., 2008), but briefly, participants were placed into a semi-immersive virtual environment where traffic flowed in a bidirectional manner across 3 computer monitors arranged in a semi-circle in front of them. Participants stood on a wooden “curb,” watching traffic from a first-person point of view. They were instructed to step down from the curb when they deemed it safe to cross. Upon stepping, participants triggered a pad which altered the point of view to third person and prompted a race- and gender-matched avatar to cross the street at the participants’ typical walking speed (as measured previously in a different room across multiple trials). The virtual environment includes ambient and traffic noise, has been validated as measuring real-world pedestrian behaviors, and appears highly realistic to college students (Schwebel et al., 2008). Figure 1 shows the virtual environment visually, and a short video of the environment is available at http://www.uab.edu/psychology/primary-faculty/11-primary-faculty/70-30-dr-david-schwebel

In this experiment, participants engaged in the virtual environment in two phases. First, familiarization was conducted by allowing participants to watch a research assistant demonstrate 2 simulated crossings (1 successful crossing and 1 unsuccessful crossing to reduce participant curiosity) and then complete 10 familiarization trials themselves. Data from familiarization trails were not used in analyses. Second, after completing questionnaires in a different room, participants re-entered the virtual environment and completed 12 crossings. These crossings were conducted in one of four randomly-assigned experimental conditions, with those assigned to a distraction condition crossing the first two times while undistracted and the final 10 times while distracted. Twelve crossings were chosen so that we could re-create real-world behavior, where initial walking might occur undistracted and then a distraction event (e.g., incoming phone call or text-message) arrived. Data from the final 10 crossings were used for analyses.

Experimental Conditions—Before engaging in the second set of pedestrian crossings (those used for data analysis rather than familiarization), participants were randomly assigned to one of four conditions: distraction by listening to music, distraction by talking on the phone, distraction by texting on the phone, or a no distraction control group. In all cases, participants were instructed to continue crossing the street even when distracted by secondary activities.

Participants randomly assigned to the listening to music group (henceforth, “music”) wore an apron with pockets (to reduce statistical noise in time/effort to retrieve devices) and were asked to place their personal music-listening devices in the pocket of the apron. Immediately after stepping down for the second crossing, an experimenter instructed participants to take their music-listening device out and begin listening to music for the remainder of the experimental trials. Participants were permitted to choose any music/songs they preferred.

Participants randomly assigned to the talking on the phone group (henceforth, “phone”) also wore the apron and were asked to place their own personal cell phones in the pocket. Immediately after stepping down for the second crossing, a previously unfamiliar experimenter located outside the room telephoned the participant and initiated a semi-structured conversation that continued through the subsequent 10 crossings. The conversation imitated a natural exchange between unfamiliar individuals; example questions included, “What is your college major?” and “Where are you from originally?”

Participants randomly assigned to the texting on the phone group (henceforth, “texting”) wore the same apron and placed their own personal phones in the pocket. As in the phone group, immediately after stepping down for the second crossing, a previously unfamiliar experimenter outside the room texted the participant and initiated a structured conversation via text messages. The conversation continued through the subsequent 10 crossings and, like the phone conversation, covered typical topics unfamiliar college students might discuss like majors, hometowns, and favorite bands. All participants were instructed to respond quickly and consistently to texts, and did so.

Measures—Five indicators of safe street crossing, adapted from previous research (Demetre, Lee, & Pitcairn, 1992; Lee, Young, & McLaughlin, 1984; Schwebel et al., 2008), were computed: (1) average time left to spare (the amount of time in seconds that elapsed after a participant safely crossed the street until the next vehicle arrived at the crosswalk); (2) looks left and right (a measure of attention to traffic based on the number of times participants looked left and right before beginning to cross the street, divided by the average time in seconds waiting to cross); (3) looks away (a measure of inattention to the street environment based on the number of seconds participants were looking away from the virtual road, divided by the average time in seconds waiting to cross); (4) hits (instances when participants would have been struck by a vehicle in a real environment); and (5) missed opportunities (number of gaps between vehicles in which participants could have crossed safely but chose not to cross);.

Three of the five pedestrian variables (time left to spare, looks left and right, and looks away) were averaged across the 10 crossings and were treated as continuous measures. The remaining two variables (hits, missed opportunities) were summed across the 10 crossings. Because the sums were non-normally distributed and heavily influenced by zero-counts, the variables were treated as binary for analysis purposes. Participants were grouped by presence or absence of hits and presence or absence of missed opportunities across the 10 crossings.

Analysis Plan

Data were analyzed in three steps. First, we considered descriptive data for all variables of interest, including both the dependent pedestrian safety measures and the covariates. Descriptive data were considered across all groups and also within the four randomly-assigned groups. Second, we computed binary regression models predicting pedestrian safety by condition. Linear regression was used for the three continuous measures and logistic regression for the two binary measures. Third, we computed multivariate regression models predicting pedestrian safety by condition with sex, age, walking frequency, and media-use frequency included as covariates in the models.

Results

Table 1 shows descriptive data, both for the full sample and for each group. Groups were comparable on the demographic characteristics measured (gender, age, and ethnicity), as well as in walking experience and typical media use (all *p*s $< .05$). We next considered differences in pedestrian behaviors while distracted. As shown in Table 2, the linear regression comparing the groups on looks away from the street environment were significant, with all three distracted groups having more looks away than the control group. The effect size for looks away in the texting group, as expected, was particularly large (beta = 0.97). The models predicting time left to spare and looks left and right were not significant, suggesting the distracted pedestrians chose gaps that allowed them to cross the street safely with as much time to spare as did the undistracted pedestrians and that all four groups looked left and right at about the same rate.

Table 3 shows logistic regressions predicting presence or absence of hits and of missed opportunities. As shown, the music and texting groups had more hits in the virtual environment than the control group. In other words, the participants who were distracted by music or by texting were more likely to be struck by a virtual vehicle than were the undistracted participants. Statistically significant differences did not emerge in the analysis with missed opportunities as the dependent variable.

The last step of analysis was to conduct multivariate regressions that included relevant covariates in the models. Replicating the bivariate regressions, we predicted time left to spare, looks left and right, and looks away using linear regression and hits and missed opportunities using logistic regression. The following covariates were also included in all models: age, gender, walking frequency aggregate, phone use frequency aggregate, texting frequency aggregate, and music listening frequency aggregate. Results were extremely similar to those in the bivariate models; all statistically significant results were retained, and no new results concerning experimental condition emerged.

Discussion

Results indicate college students' pedestrian safety might be jeopardized by the distraction of using handheld multimedia devices. Participants who listened to music or texted while crossing the street experienced more hits by vehicles in the virtual pedestrian environment than did participants who were not distracted. We also found that all three groups of distracted pedestrians looked away from the street environment while waiting to cross the street more often than the undistracted pedestrians.

Several other findings were surprising. First, it was unexpected that the music and texting groups experienced more hits in the virtual pedestrian environment than the undistracted participants did, but that the phone group did not. This finding contrasts reports with children (Stavrinos et al., 2009), adults (Neider et al., 2010; Stavrinos et al., 2011), and older adults (Neider et al., 2011) that found increased risk among pedestrians talking on the phone compared to undistracted controls. If the result is replicated, it may be explained by the fact that both texting and listening to music involve mental processes different from a telephone conversation. Texting, which involves not only communication interchanges but also reading and typing, may be more cognitively distracting and demanding than talking. One would expect that cognitive pauses to re-focus on other critical activities like judging traffic safety might be possible while texting, but participants in our study made several errors while texting.

Listening to music involves somewhat less cognitive complexity than a conversation, and has been shown in previous work to have minimal influence on safe automobile driving (Bellinger et al., 2009; Dibben & Williamson, 2007) and, in one study, on safe pedestrian behavior (Neider et al., 2011). It may lead to some disconnected pedestrian behavior, however (Nasar et al., 2008). One thing that listening to music does create, unlike the other distractions, is a constant disruption of auditory signals. Though studied sparsely in the literature, early research suggests aural cues may be quite important to judging the safety of pedestrian environments (Barton, Kovesdi, Cottrell, & Ulrich, 2011; Pfeffer & Barnecutt, 1996). Our virtual environment had aural cues that the music-listeners may not have heard over their music, and the lack of aural stimulation may have influence safety.

Finally, it was surprising that the distracted groups did not miss more safe opportunities to cross than the undistracted group (though note the non-significant trend for more missed opportunities among the phone group in Table 1). It may be that skilled pedestrians are able to multi-task street-crossing with other activities to some extent, although their attempt to multitask might break down on occasion, leading to the increased rate of hits we detected in the music and texting groups. It may also be that our instructions to “continue crossing the street even when distracted” led distracted participants to cross when possible and not miss opportunities. Future research might adjust experimental instructions.

Taken together, the results suggest distraction may have a small but meaningful impact on safe pedestrian behavior among college students. The results have implications for future research and for intervention and policy. From a research perspective, further work is needed to understand the cognitive processes of crossing a street safely that may be disrupted by distraction. Pedestrian behavior requires a complex set of cognitive skills including attentional processes, visual and aural perceptual processes, information processing, decision-making, and motor initiation. It is unclear which processes may be impacted by distraction, which types of distraction may impact which cognitive processes, and how individual differences may impact the influence of distraction. Future work using ecologically-valid methodology such as virtual environments is needed. The work should learn and build from findings in automobile driving research, but also should examine pedestrian behavior independently, as some of the processes involved in pedestrian safety are different from those in driving safety.

From an intervention and prevention perspective, these findings confirm the possibility that distraction from handheld multimedia devices can jeopardize pedestrians’ safety. Educational campaigns in places where pedestrian behavior is common – at college campuses and in urban cities, for example – are warranted and could be successful. Environmental modifications to preserve pedestrian safety also could be effective. Pedestrian bridges, for example, protect all pedestrians, including those who are distracted, by removing them from the hazardous environment (Fraser, 2011; Híjar, Vazquez-Vela, & Arreola-Risa, 2003).

The findings also have implications for policy. The institution of laws prohibiting driving while distracted by telephone conversations or texting apparently results in decreased crash and injury rates (Huang et al., 2010; Jacobson & Goston, 2010). Implementing and then enforcing prohibitions of distracted pedestrian behavior will be very challenging, but might be effective.

Like all research, this study had strengths and limitations. Among the strengths were the use of a validated interactive, semi-immersive virtual pedestrian environment to assess behavior and recruitment of a diverse sample representing a college student population living on an urban campus where they cross busy streets very frequently. One major limitation was our statistical power. We anticipated many of our results would have a large effect size and we had sufficient power (0.97) to detect such an effect. However, our power to detect a medium effect size was only 0.63. Also limiting were our recruitment from a single college campus, our unverifiable assumption that random assignment to groups was effective, and our use of self-report recall measures for covariates such as walking history and technology use. Finally, we note that we requested participants to continue crossing the street even while distracted. Some college students might choose not to cross streets while distracted by music, phone calls, or text-messaging although almost most students believe themselves safe while distracted in those ways and continue crossing streets even if they are distracted (Byington, Renfroe, Fetterer, & Schwebel, 2011).

In conclusion, our study suggests listening to music, talking on the phone, or texting may impact college students' safety crossing streets by distracting them from the street environment and leading to risk of collisions with traffic.

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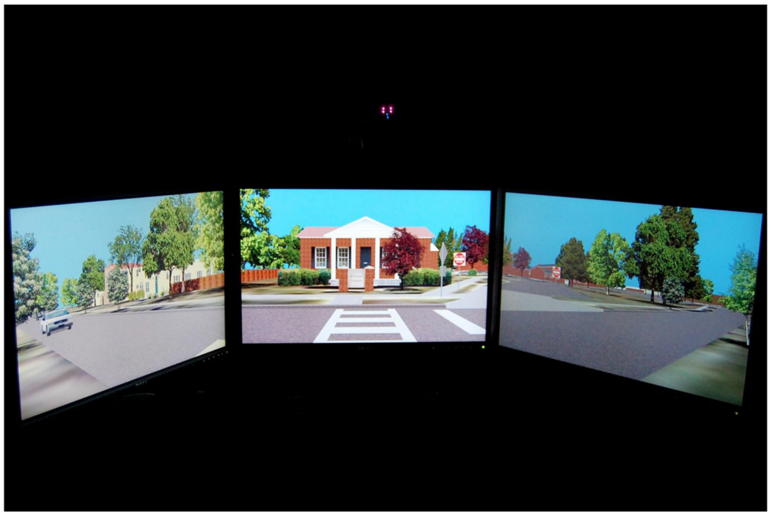

Figure 1.
Photograph of virtual environment.

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Table 1

Characteristics of Sample (Percentage of Sample Listed)

Variable	Total (N=128) M (SD) or %	Music (n=34) M (SD) or %	Phone (n=33) M (SD) or %	Texting (n=30) M (SD) or %	Control (n=31) M (SD) or %
Male Gender	36%	34%	42%	28%	42%
Age (years)	20.91 (4.50)	21.21 (5.65)	20.68 (3.19)	20.00 (2.91)	21.78 (5.44)
Ethnicity					
White	54%	45%	58%	63%	51%
African American	26%	34%	12%	22%	33%
Other	20%	21%	31%	16%	15%
Walking Experience					
Average Time Walking (Min.)	38.14 (23.89)	32.82 (18.82)	39.41 (22.36)	42.44 (26.80)	38.33 (27.78)
Average Blocks Walked	10.63 (17.41)	7.43 (4.17)	11.19 (7.11)	9.24 (4.81)	15.03 (34.18)
Media Use					
Phone Talking – Weekdays (Min.)	117.82 (142.22)	97.22 (84.67)	97.42 (134.12)	158.41 (212.44)	114.85 (106.58)
Phone Talking – Weekend Days (Min.)	143.30 (137.20)	128.33 (133.26)	113.03 (102.79)	160.74 (128.62)	158.03 (158.48)
Texts Sent – Weekdays	80.98 (143.45)	66.45 (95.48)	40.48 (49.29)	87.03 (155.45)	123.18 (214.26)
Texts Sent – Weekend Days	117.72 (300.58)	88.97 (145.43)	51.58 (73.49)	113.28 (192.83)	209.35 (548.17)
Music Use – Weekdays (Min.)	120.88 (194.13)	151.39 (273.27)	113.46 (218.19)	114.05 (126.39)	96.24 (104.43)
Music Use – Weekend Days (Min.)	75.50 (103.91)	65.40 (85.91)	80.61 (3.19)	100.53 (130.33)	53.52 (58.27)
Pedestrian Behaviors					
Time Left to Spare	3.23 (0.80)	3.15 (0.89)	3.12 (0.67)	3.26 (0.84)	3.44 (0.77)
Looks Left and Right/Wait Time	0.56 (0.12)	0.58 (0.12)	0.54 (0.15)	0.56 (0.11)	0.56 (0.11)
Looks Away/Wait Time	0.07 (0.11)	0.03 (0.05)	0.01 (0.01)	0.23 (0.11)	0.00 (0.00)
Hits (1+)	19%	32%	12%	25%	6%
Missed Opportunities (1+)	18%	13%	33%	13%	15%

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Table 2

Bivariate Linear Regressions: Condition Predicting Pedestrian Behavior

	Time Left to Spare (R^2 = .24)			Looks Left and Right[1] (R^2 = .02)			Looks Away[1] (R^2 = .75)		
Variable	**B**	**SE B**	***β***	**B**	**SE B**	***β***	**B**	**SE B**	***β***
Music	−0.29	0.20	−0.16	0.02	0.32	0.06	0.10	0.02	0.24**
Phone	−0.31	0.20	−0.17	−0.03	0.03	−0.09	0.06	0.02	0.15*
Texting	−0.19	0.20	−0.10	−0.01	0.03	−0.02	0.42	0.02	0.97**
Undistracted Control Group	(referent)								

** $p < .01$.

* $p < .05$.

[1] Looks variables were divided by wait time to control for opportunity. Looks away over wait time was also transformed by squareroot transformation to improve normality.

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Table 3

Bivariate Logistic Regressions: Condition Predicting Pedestrian Behavior

	Hits		Missed Opportunities	
Variable	**OR**	**95% CI**	**OR**	**95% CI**
Music	7.91*	1.60, 39.03	0.90	0.23, 3.45
Phone	2.00	0.34, 11.79	2.60	0.78, 8.63
Texting	5.27*	1.02, 27.33	0.80	0.19, 3.32
Undistracted Control Group	(referent)			

* $p < .05$.